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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF APPEALS AND INTERFERENCES

In re Patent Application of
Roger F. BAINES
Serial No.: 07/702,615
Filed: May 17, 1991
For: ELECTRIC MOTOR WITH BRUSH ASSEMBLY SUPPORTING TWO SEPARATELY FORMED BRUSHES

New York, New York
Date: January 18, 1994
Group Art Unit: 2102
Examiner: R. Skudy

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Hon. Commissioner of Patents
and Trademarks
Washington, D.C. 20231

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APPEAL BRIEF UNDER 37 C.F.R. §1.192

Sir:

This appeal concerns the propriety of the Examiner's final rejection of this application.

Status of Claims

Claims 5-7 and 9-42 are pending and on appeal herein. Claims 1-4 and 8 have previously been cancelled.

Status of Amendments

An Amendment After Final Rejection was filed November 15, 1993, and was entered, according to the Advisory Action dated November 30, 1993.

Summary of Invention

The invention relates to an improvement in a brush assembly for a DC electric motor (Fig. 1) which has a commutator

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12 with a plurality of separate, circumferentially-arranged segments. Electrical contact between a power supply circuit and the commutator is provided by at least one brush which is supported by a brush arm. In the invention, the brush-commutator interface resistance is reduced by a new, advantageous feature not seen in the prior art; namely, a brush assembly having a pair of brushes 20, 21 which are electrically in parallel, are spaced axially along the length of the commutator, and have different mechanical resonant frequencies. See, for example, the pair of brushes 20, 21 on the left side of Fig. 2.

The pair of brushes 20, 21 are disposed for contacting the commutator simultaneously; or in other words, they are adjacent the same given segment of the commutator at a given point in time.

A pair of parallel brushes on the same side of the commutator is known per se, as shown for example in Watanabe, U.S. Patent 4,086,510. The conventional way of improving the electrical contact between such brushes and the commutator is simply to increase the pressure of the brushes on the commutator, which increases wear and power loss due to heat. In contrast, according to the invention, improved electrical contact can be obtained by providing the brushes 20, 21, combined with their respective supporting parts 18, 19, with different respective mechanical resonant frequencies. Thus, even if there is some bouncing of the brushes with respect to the commutator, the respective bounces of the two brushes will occur at different points in time due to their different resonant frequencies, so it is likely that at least one brush will be in contact with the commutator at all times. Further, if the motor speed corresponds to the resonant frequency of one brush, it will not correspond to that of the other brush, so the other brush will be less likely to lose contact with the commutator. Page 5, lines 2-7. Thus the brush-commutator interface electrical resistance is reduced, improving current conduction.

The different resonant frequencies of the brushes may be obtained in several different ways. The brushes may have different weights or densities. Slots, apertures, or narrow portions (see Fig. 3A) may be formed in the brush arms. Various claims are directed to different structures that provide the different resonant frequencies.

A second pair of brushes may be arranged for contacting the commutator at a location diametrically opposite the first pair of brushes. The second pair of brushes are termed "third and fourth brushes" and they are supported on "third and fourth support arms," according to some of the claims. The "first and second" supporting parts and brushes are on the left side of Fig. 2. The "third and fourth" elements are on the right side of Fig. 2. Again, the third and fourth brushes are spaced axially along the commutator so they are capable of substantially simultaneously contacting a single respective segment of the commutator. And again, it is disclosed to be highly advantageous for the third and fourth brushes to have different resonant frequencies in combination with their respective support arms.

Issues

Did the Examiner correctly reject claims 6, 7 and 10-42 under 35 U.S.C. 112, first and second paragraphs?

Did the Examiner correctly reject claims 19-23 and 37-40 and object to the specification, under 35 U.S.C. 112, first paragraph?

Did the Examiner correctly reject claims 5-7, 9-14, 17-20, 24-33 and 40-42 under 35 U.S.C. 103 in view of either Muller alone, or Baines in view of Muller?

Did the Examiner correctly reject claims 15, 16, 21-23 and 34-39 under 35 U.S.C. 103 in view of the foregoing references, and further in view of Watanabe and Hargreaves?

Grouping of Claims

Each claim discussed below is considered to be independently patentable for the reasons stated. Any claims not discussed below will "stand or fall" with the claims from which they depend.

Argument

This is responsive to the grounds for objection and rejection in the final Office Action dated May 14, 1993.

I. Response to Rejections on Page 2 Under 35 U.S.C. §112, First and Second Paragraphs

A. Introduction

At page 2, the final Office Action lumped together both the first and the second paragraphs of 35 U.S.C. §112. The Examiner cited several phrases from the claims as being objectionable, but in some cases, it was not clearly stated why the Examiner did not understand those phrases or why they were cited.

The Amendment After Final Rejection responded to the grounds on page 2 to the best of our understanding. The undersigned attorney for the applicant offered to have a telephone interview with the Examiner if further amendments were necessary to satisfy the Examiner's requirements. Since the Examiner did not request a telephone interview, we believe that all of the 35 U.S.C. 112 issues were eliminated by the Amendment After Final Rejection.

Nevertheless, the Advisory Action did not say that the 112 issues have been resolved. Issues may remain to be decided by the Board of Appeals. Therefore, it is necessary for us to respond in this Appeal Brief to all of the 35 U.S.C. 112 rejections and objections.

B. Detailed Response to Rejections on Page 2

The Examiner rejected claims 6, 7 and 10-42 under 35 U.S.C. §112, first and second paragraphs. The grounds for rejection will be discussed in turn.

The Examiner stated at lines 7-13 on page 2 that certain claim phrases have "no antecedent basis."

The Examiner objected to the terms "a commutator," "the motor," and "the same time" in claims 6, 7 and 15. These claims were amended to satisfy the Examiner's requirements. The rejection of claims 6, 7 and 15 should therefore be reversed.

The Examiner said that the phrase "said first and second support arms" in claims 10-14 has "no antecedent basis." That phrase finds antecedent support in lines 3-4 of claim 7. It is also noted that the phrase "said first and second support arms" does not appear in claim 14. Therefore, the rejection of claims 10-14 is requested to be reversed.

The Examiner objected to the phrase "said third and fourth support arms" in claims 15, 16, 37 and 39. That phrase in claims 15, 16 and 37 finds antecedent basis in lines 2-3 of claim 15. The phrase "third and fourth support arms" does not appear in claim 39. Therefore, this rejection should be reversed.

The Examiner objected to "said first support" and "said second support" in independent claims 17 and 33. However, there is nothing of record to indicate why these terms lack antecedent basis or are unclear to an individual having ordinary skill in this art in the context of this patent application. Therefore, this rejection should be reversed.

The Examiner also objected to "said first support" in claims 24 and 28, which phrase has antecedent basis in claim 17 and is therefore submitted to be proper. The Examiner's objection to "said first and second supports" in claim 38 is also respectfully traversed. Claim 38 depends from claim 17 which explicitly provides antecedent basis for the "first and second supports" at lines 3-4. Therefore, the rejection of claims 24, 28 and 38 should be reversed.

The Examiner stated that "said different resonance frequencies" in claim 42 has no antecedent basis. The claim is not believed to require amendment. That phrase appears in claim 42 at lines 11-12 and is supported by the preceding lines 8-9 in claim 42. The rejection of claim 42 should be reversed.

The Examiner stated at lines 13-18 on page 2 of the Office Action, that several phrases in claims 7, 13, 15, 16, 34 and 37-39 were "insufficiently supported in the specification." The specification has been amended to correspond with the claim language the Examiner has pointed out. See page 3, lines 9 and 19; page 4, line 13; and page 5, line 1. In particular, the phrases "plurality of circumferential segments . . . the support arms being connected electrically in parallel" in claim 7, "an aperture" in claim 13, "third and fourth support arms" in claims 15, 16, 37 and 39, "third and fourth brush bodies" in claims 15, 34 and 37, and "third and fourth brushes" in claim 38, are supported in the specification. Therefore, the rejection of these particular claims is now requested to be reversed.

Therefore, the rejection of claims 6, 7 and 10-42 on page 2 of the final Office Action is requested to be reversed.

II. Response to Objection to Specification and Rejection of Claims 19-23 and 37-40 Under 35 U.S.C. §112, First Paragraph

At page 3 of the Office Action, the Examiner objected to the specification and rejected claims 19-23 and 37-40 under 35 U.S.C. 112, first paragraph.

A. The Examiner's Reference to "New Matter" is Traversed

At page 3, line 19, the Office Action refers to "new matter." However, there is no rejection of any of the claims under 35 U.S.C. §132, nor any indication of any new matter entered into the disclosure as prohibited by 35 U.S.C. §132. It is therefore concluded that there is no new matter rejection requiring a response.

B. Detailed Response to Rejections on Page 3

The Examiner has objected to an alleged lack of word-for-word correspondence between the specification and certain phrases in claims 19, 20, 22, 23, 33, 37 and 38-40. See page 3, lines 4-22 of the Office Action. The Examiner has also rejected claims 19-23, and 37-40 under 35 U.S.C. §112, first paragraph, on the same grounds.

The features in claims 20 and 23 are supported by the specification at page 3, line 11, in view of Figs. 1 and 2 and the general state of the art regarding the normal operation of a DC motor. The features in claim 22 are supported by the specification as amended at page 3, line 19, which indicates that the supporting parts 18, 19 and the brushes 20, 21 on the left side of Fig. 2 will be referred to as "first" and "second," while the corresponding elements on the right side of Fig. 2 will be referred to as "third" and "fourth." Claim 22 is further supported by, for example, page 2, lines 4-7, which states that the separate arms in each pair of arms may be arranged to have different natural resonance frequencies of oscillation. The feature in claim 33 is supported by amended page 4, line 21, which in turn is supported by Fig. 3. The features recited in claims 37-40 are supported by the specification, for example, at page 5, lines 3-7 and 17-21.

For all these reasons, the objections to the specification and rejection of claims 19-23 and 37-40 on page 3 under 35 U.S.C. §112, first paragraph, are requested to be reversed.

III. Prior Art Rejections

A. Rejection Over Baines and Muller

Claims 5-7, 9-14, 17-20, 24-33 and 40-42 were rejected as being obvious over either Baines in view of Muller, or Muller alone.

1. Summary of Argument

The prior art does not suggest a pair of brush arms and brushes, longitudinally spaced side-by-side along a commutator of a DC motor, having different respective natural resonance frequencies of oscillation, and the other features mentioned in independent claims 7, 17, 33 and 42.

Muller does not even disclose a motor. None of the motor-related elements in independent claims 7, 17, 33 and 42 are disclosed by Muller. The rejection over Muller alone should be reversed.

The Examiner argued that Muller teaches arms with different resonance frequencies contacting a rotating shaft, but that is irrelevant because Muller's "arms" are on opposite sides of the rotating surface they contact. They are not axially spaced from each other with respect to a longitudinal axis of a DC motor as recited in the present claims, for example claims 7, 33 and 42; nor do they extend toward a common circumferential region of the commutator as claimed in claim 17.

The Examiner proposed modifying Baines (which discloses a conventional motor) in view of Muller. But Baines does not supplement the Examiner's argument, because as acknowledged in the Office Action dated April 14, 1992, Baines does not teach any support arms and brushes having different resonant frequencies. Neither of the references discloses any reason to modify two or more side-by-side brush contacts for electrical engagement with a rotating cylindrical body such as a commutator, as claimed herein, so that they have different resonant frequencies. Such modification is not shown to be either possible or desirable, for any purpose (such as to supply an electric motor with higher current without increasing current density or mechanical pressure at the interface between the stationary contacts and the rotating cylindrical body, as here). Thus, the objects of the present invention, the problems it solves and the solutions thereto, are neither disclosed nor suggested by Muller and Baines, individually or in combination.

The Examiner has pointed out additional references that are said to relate to third and fourth brushes, such as Watanabe and Hargreaves, but those references neither disclose nor suggest that the respective brushes in each brush assembly have different resonance frequencies, as claimed.

Therefore, none of the prior art cited in the final Office Action supports a rejection of the present claims.

2. Muller's Teachings Regarding Resonant Frequencies are Irrelevant to This Invention The Examiner cited Muller (Fig. 3) as teaching wiper arms for engaging a rotating shaft, which, in his view, are analogous to brushes and support arms for brushes in a motor. The Muller reference states that the wiper arms have different resonant frequencies. Therefore, in the Examiner's view, it is obvious to modify the brushes in the primary references such as Baines, so that they will have different resonant frequencies.

The Muller reference is irrelevant to the claimed invention. Muller was concerned with solving a different problem than that solved by the present invention. It neither discloses nor suggests the features now claimed. Any combination of Muller and Baines would be based only on hindsight, inspired by the present inventor's disclosure in this patent application.

Claims 7, 18, and 33 specify that the first and second supports or support arms are mounted so as to be spaced axially with respect to the rotating commutator at the axis of the motor.

The problem to be solved is keeping at least one of the first and second axially-spaced brushes in good contact with the given commutator portion at a given time. With the invention, since the first and second support/brush combinations have different resonant frequencies, then even if the brushes are bouncing along the surface of the commutator, they will not be bouncing at the same frequency and therefore one of the brushes will most likely be in contact with a given circumferential

portion of the commutator at a given time, which is highly advantageous for maintaining proper operation of the motor.

There are no such axially spaced wiper arms in Muller. Muller never considered the problems of maintaining axially spaced brushes i.e., brushes on the same side of a commutator, in contact with the commutator. Therefore, Muller cannot disclose any relevant teachings for solving that problem.

Further, claims 7, 15, 17, 19-20 and 23 specify that the claimed first and second (or third and fourth) brushes are arranged for contacting the same circumferential segment or region of the commutator, that is, for contacting the commutator at substantially the same position around its circumference. In Muller, the two wiper arms are not at the same circumferential region around the rotating shaft, but rather are at opposed regions on different parts of the rotating shaft.

Even if Muller were combined with other references, for example with the Baines reference as the Examiner has proposed, such a combination would not have the features now claimed. Muller's teachings relate to wiper arms which engage <u>different circumferential portions on different sides</u> of a rotating shaft. Muller teaches nothing about the pair of wiper arms or motor brushes on <u>the same side</u> of a commutator in the arrangement of claims 7, 17, 33, and 42. If Muller were combined with the Baines reference, even assuming such a combination were proper, Muller would teach <u>at most</u> that a brush on <u>one</u> side of a commutator should have a different resonant frequency than a brush on <u>another</u> side of the commutator. Muller's teachings would not suggest the arrangement set forth in the independent claims, i.e., Muller would <u>not</u> require that the first and second brushes have different frequencies. On the contrary, the first and second brush/support arm combinations might well have <u>the same</u> resonant frequency, contrary to the express requirements of claims 7, 17, 33, and 42 and the dependent claims. Such a result is not ruled out by Muller.

If there were third or fourth brushes on a different side of the commutator from the first and second brushes, the third and fourth brushes might also have the same frequency as each other.

At most, Muller teaches, for the sake of argument, that the frequency of the third and fourth brushes should be different from the frequency of the first and second brushes. But that is not the claimed invention. Thus, Muller fails to suggest the arrangement of claims 15, 16, 21-23, 34, 35, 37 and 39.

Furthermore, Muller does not teach resonant frequencies of brushes on diametrically opposite sides of a rotating shaft, as claimed in claims 34 and 35. As clearly shown in Fig. 3 of Muller, according to basic trigonometry, the contact points of the wiper arms on the rotating shafts will not be diametrically opposite to each other, but will both be slightly displaced in the direction toward the left as shown in Muller's Fig. 3.

Claims 36-40 depend respectively from claims 7, 16, 17, 22 and 33, and recite specifically that the different resonant frequencies of the brushes and support arms recited in the independent claims enable the two brushes to provide reliable electrical contact between the support arms and the commutator, by reducing the interface resistance between the brush bodies and the commutator, despite oscillations of the arms and brushes that occur in response to rotation of the commutator. This feature is supported, for example, at pages 1 and 5-6 of the specification. No such feature is seen to be either disclosed or suggested by the prior art. Neither Baines nor Muller is relevant to solving these particular problems in a DC motor.

For at least the above reasons, the resonant frequency teachings of the Muller reference, or Muller in combination with Baines, cannot suggest the invention as now claimed.

3. Muller's Frequency-Setting Technique Fails to Suggest the Invention

The different resonant frequencies in Muller are obtained by providing the wiper arms with different lengths. Even assuming that Muller could be combined with Baines, nothing in Muller or Baines can suggest the features of claim 33 and its dependent claim 40, which specify that the first and second support arms have substantially the same length.

Nor can Muller suggest the subject matter of claims 5, 6, 9-13, 24-31, 41 and 42 which state that the different resonant frequencies of the support/brush combinations are obtained by different shapes or sizes or densities of the brush, or different resiliencies of the support, which are obtained, for example, by providing a slot or a different dimension of at least one of the supports. None of these features are shown in the references.

Nor can Muller suggest claims 24-31, which specify that at least one of the first brush and the first support has adjusting means for causing the first frequency to be different from the second frequency. Even if the features of the prior art resulted in particular frequencies as the Examiner has alleged, the prior art suggests no such "adjusting means" as claimed.

Nor does Muller suggest an "interference fit" as claimed in claim 14 and 32.

Since Muller teaches providing its "wiper arms" with different resonant frequencies by providing them with different lengths, Muller cannot suggest the frequency-adjusting features disclosed and claimed herein. For these reasons as well, the rejections should be reversed.

4. Muller's Teachings Are Non-Analogous Prior Art and Teach Away from the Invention

Further, the teachings of Muller are not applicable in the field of brushes for a DC motor. The natural frequency of the brush/support combination is essentially determined by the resiliency of the support and/or the weight of the brush. The

weight of the brush is by far the most significant part of the overall weight of the support arm together with the brush. Adjusting the length of the support arm, as in Muller, would have very little practical effect. The natural resonant frequency of the brush/support arm combination would be virtually unaltered by having different arm lengths, bearing in mind that the support arms are supported at substantially the same radial distance from the axis of the motor.

In other words, in the context of a DC motor, the natural frequency of a resilient support arm pressing a brush body against a commutator is much more dependent on the flexibility of the arm and the weight of the brush, than on the length of the arm itself. The solution proposed by Muller would be essentially useless in the context of a DC motor, and in fact is not employed according to the present invention, as defined in the claims.

The only reason Muller would have any practical applicability, if it does, is that the wiper arms in Muller do not have relatively heavy brush bodies at their ends.

Thus, Muller is non-analogous prior art and cannot be combined with Baines. A skilled individual, reviewing the Muller reference, would discount the Muller reference and would not combine it with Baines, since its teachings are useless in the context of a DC motor.

Muller also teaches away from the invention of claims 7, 17, 33 and 42 which include a support and a brush, because Muller's arrangement would be useless for its intended purposes if a relatively heavy brush were somehow grafted onto Muller's wiper arms.

5. Muller's Structural Teachings do not Suggest the Invention

Of the prior art relied on by the Examiner, Baines (U.S. 4,728,835), and Muller (U.S. 3,671,791), neither reference is concerned with unequal natural frequencies of two or more

side-by-side brush contacts for electrical engagement with a rotating cylindrical body, such as a commutator or a slip ring, for the purpose of supplying an electric motor with higher current without increasing current density at the interface between the stationary contacts and the rotating cylindrical body.

Although Muller discloses the use of a wiper member 13 having two contact arms 6, the purpose of the wiper member 13 is merely to provide an electrical connection between a fixed contact pin 5 and the rotating slip ring 7 of a function generator. Muller does not provide two arms in order to provide two redundant current paths. Rather, the provision of the wiper member 13 with two arms is solely for the purpose of providing the wiper member 13 with a "U-shaped end portion" (see line 10, column 1) which (as explained at lines 50 to 54, column 2) can be formed into a C-shaped end 14 for attaching the wiper member 13 to the pin 5. As the wiper member 13 is merely required to engage the slip ring 7 of a function generator 8, there is no disclosure of any advantage to be obtained in providing multiple brushes for improving current flow at the interface between the wiper member 13 and the slip ring 7, as in the present invention.

In fact, the assembly disclosed by Muller will apparently function even when the wiper member 13 has only one leg engaging the slip ring 7. This is clear from the disclosure at lines 27 to 31, column 2, where it is explained that the additional use of solder to fasten the wiper member 13 to the pin 5 improves operation even "if one arm breaks" so that the only engagement is provided by the other arm.

For these reasons as well, there is no motivation in either the prior art or the present application for a combination of Muller and Baines as suggested by the Examiner.

B. Rejection Over Secondary References

Claims 15, 16, 21-23 and 34-39 were rejected over the foregoing references and further in view of Watanabe, Figs. 1 and 2, and Hargreaves, Fig. 7. Neither Watanabe nor Hargreaves adds anything to the primary references. They merely disclose conventional arrangements including third and fourth brushes. Neither Hargreaves nor Watanabe suggests the resonant frequency features now claimed in claims 15, 16, 21-23 and 34-39 and their parent claims, individually or in combination with Muller and Baines.

The rejection of claims 15, 16, 21-23 and 34-39 should be reversed at least for these reasons.

Conclusion

For all the above reasons, the rejection of claims 5-7 and 9-42 is requested to be reversed.

If this Appeal Brief is filed after a shortened statutory time period has elapsed and no separate Petition is enclosed, the Commissioner of Patents and Trademarks is petitioned, under 37 C.F.R. §1.136(a), to extend the time for filing this Appeal Brief by the number of months which will avoid abandonment under 37 C.F.R. §1.135. The fee under 37 C.F.R. §1.17 or any other fees that may be due should be charged to our Deposit Account No. 15-0700.

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Commissioner of Patents and Trademarks, Washington, D.C. 20231, on January 18, 1994:

James A. Finder
Name of applicant, assignee or Registered Representative

Signature

January 18, 1994
Date of Signature

Respectfully submitted,

James A. Finder
Registration No.: 30,173
OSTROLENK, FABER, GERB & SOFFEN
1180 Avenue of the Americas
New York, New York 10036-8403
Telephone: (212) 382-0700

JAF:rk/rdj

The Claims on Appeal Are:

5. A brush assembly according to claim 7, in which the brush bodies are of different weights.

6. A fractional horsepower direct current electric motor having the commutator and the brush assembly according to claim 7.

7. An electric motor brush assembly for being mounted in a DC motor, comprising:

at least first and second resilient, electrically conductive support arms arranged for being axially spaced from each other with respect to a longitudinal axis of a DC motor when said assembly is mounted in the motor,

each arm carrying a respective brush body which is arranged for contacting a commutator of the motor,

the commutator having a plurality of circumferential segments and the first and second brush bodies being disposed for contacting a single one of said segments at a same time when the assembly is mounted in the motor,

the support arms being connected electrically in parallel,

each arm in combination with the respective brush body thereof having a different respective natural resonance frequency of oscillation.

9. A brush assembly according to claim 5, wherein said brush bodies have different sizes, thereby having said different weights.

10. A brush assembly according to claim 7, wherein said first and second support arms have different respective resiliencies so as to have said different frequencies.

11. A brush assembly according to claim 10, wherein at least part of said first and second support arms are made of different materials for providing said different respective resiliencies.

12. A brush assembly according to claim 10, wherein at least part of at least one of said first and second support arms has a different dimension from the other support arm for providing said different respective resiliencies.

13. A brush assembly according to claim 10, wherein at least one of said first and second support arms has an aperture formed therein for providing said different respective resiliencies.

14. A brush assembly according to claim 7, wherein each said brush body is mounted by an interference fit in an aperture in the respective support arm thereof.

15. A brush assembly according to claim 7, further comprising third and fourth resilient, electrically conductive support arms arranged for being axially spaced from each other with respect to said longitudinal axis of said motor when said assembly is mounted in the motor, said third and fourth support arms carrying respective third and fourth brush bodies which are arranged for contacting said commutator of the motor, the commutator having a plurality of circumferential segments and the third and fourth brush bodies being capable of contacting a single one of said segments at a same time, the third and fourth support arms being connected electrically in parallel.

16. A brush assembly according to claim 15, wherein said third and fourth support arms in combination with the respective brush bodies thereof have different respective natural resonance frequencies of oscillation.

17. An electric motor brush assembly for being mounted in a DC motor comprising:

first and second resilient, electrically conductive supports arranged for being mounted in such motor, the supports carrying respective first and second brushes which are thereby arranged for contacting a commutator at an axis of such motor when the assembly is mounted in the motor;

the supports being mounted to a common base which is spaced from the axis of said motor and the brushes extending toward a common circumferential region of said commutator;

said first support and brush having a first resonant frequency, said second support and brush having a second resonant frequency, and said first and second resonant frequencies being different.

18. A brush assembly as in claim 17, wherein said supports are connected electrically in parallel with each other, and are arranged in the assembly for being axially spaced from each other with respect to a longitudinal axis of said motor.

19. A brush assembly as in claim 18, further comprising an end cap, said supports being mounted on said end cap, said brushes being mounted on said end cap via said supports for contacting the commutator of the motor, said commutator having a circumference, and said brushes being mounted so as to be at substantially a common position around said circumference.

20. A brush assembly as in claim 19, wherein said commutator has a plurality of segments and said first and second brushes are mounted so as to be capable of contacting a common one of said segments simultaneously.

21. A brush assembly as in claim 19, further comprising third and fourth supports mounted on said end cap and third and fourth brushes mounted on said end cap via said third

and fourth supports for contacting the commutator of the motor, and said third and fourth brushes being mounted so as to be at substantially different positions around said circumference than said first and second brushes.

22. A brush assembly as in claim 21, said third support and brush having a third resonant frequency, said fourth support and brush having a fourth resonant frequency, and said third and fourth resonant frequencies being different.

23. A brush assembly as in claim 21, wherein said commutator has a plurality of segments and said third and fourth brushes are mounted so as to be capable of contacting a common one of said segments simultaneously.

24. A brush assembly as in claim 17, wherein at least one of said first support and said first brush has adjusting means for causing said first frequency to be different from said second frequency.

25. A brush assembly as in claim 24, wherein said adjusting means is a portion of said first brush having a different shape than a corresponding portion of said second brush.

26. A brush assembly as in claim 24, wherein said adjusting means is a portion of said first brush having a different size than a corresponding portion of said second brush.

27. A brush assembly as in claim 24, wherein said adjusting means is a material in said first brush which has a different density than a corresponding material in said second brush.

28. A brush assembly as in claim 24, wherein said adjusting means is a portion of said first support having a different resiliency than a corresponding portion of said second support.

29. A brush assembly as in claim 28, wherein said portions of said supports are made of different resilient materials, thereby having said different resiliencies.

30. A brush assembly as in claim 28, wherein said portions of said supports have a different dimension, thereby having said different resiliencies.

31. A brush assembly as in claim 28, wherein one of said portions has a slot formed therein, which provides said different resiliencies.

32. A brush assembly as in claim 17, wherein each said brush is mounted by an interference fit in an aperture in the respective support thereof.

33. An electric motor brush assembly for being mounted in a DC motor comprising:

first and second resilient, electrically conductive supports arranged for being mounted in such motor, the supports carrying respective first and second brushes which are thereby arranged for contacting a commutator at an axis of such motor when the assembly is mounted in the motor;

the supports being axially spaced from each other with respect to said axis of said motor and the supports having substantially equal lengths;

said first support and brush having a first resonant frequency, said second support and brush having a second resonant frequency, and said first and second resonant frequencies being different.

34. A brush assembly according to claim 15, wherein the third and fourth brush bodies are substantially diametrically opposite the first and second brush bodies with respect to said motor axis.

35. A brush assembly according to claim 21, wherein the first and second brushes are substantially diametrically opposite the third and fourth brushes with respect to said motor axis.

36. A brush assembly according to claim 7, wherein said different resonant frequencies enable the two brush bodies to provide reliable electrical contact between said first and second support arms and said commutator, by reducing interface resistance between the brush bodies and the commutator, despite oscillations of said arms and brush bodies which occur in response to rotation of said commutator.

37. A brush assembly according to claim 16, wherein said different resonant frequencies enable the third and fourth brush bodies to provide reliable electrical contact between said third and fourth support arms and said commutator, by reducing interface resistance between the brush bodies and the commutator, despite oscillations of said arms and brush bodies which occur in response to rotation of said commutator.

38. A brush assembly according to claim 17, wherein said different resonant frequencies enable the first and second brushes to provide reliable electrical contact between said first and second supports and said commutator, by reducing interface resistance between the brushes and the commutator, despite oscillations of said supports and brushes which occur in response to rotation of said commutator.

39. A brush assembly according to claim 22, wherein said different resonant frequencies enable the third and fourth brushes to provide reliable electrical contact between said third and fourth supports and said commutator, by reducing interface resistance between the brushes and the commutator, despite oscillations of said supports and brushes which occur in response to rotation of said commutator.

40. A brush assembly according to claim 33, wherein said different resonant frequencies enable the first and second brushes to provide reliable electrical contact between said first and second supports and said commutator, by reducing interface resistance between the brushes and the commutator, despite oscillations of said supports and brushes which occur in response to rotation of said commutator.

41. A brush assembly according to claim 5, wherein said brush bodies contain respective materials having different densities so as to have said different weights.

42. An electric motor brush assembly comprising at least two resilient, electrically conductive support arms, arranged for being axially displaced with respect to a longitudinal axis of a motor when the brush assembly is installed in a motor, each arm of the assembly being arranged to carry a respective brush body, the support arms being connected electrically in parallel, each arm in combination with the respective brush body having a different respective resonance frequency of oscillation;

in which the brush bodies are substantially equal in size but made of different density material so as to provide said different resonance frequencies.